

# Problems detecting radiation effects in the natural environment

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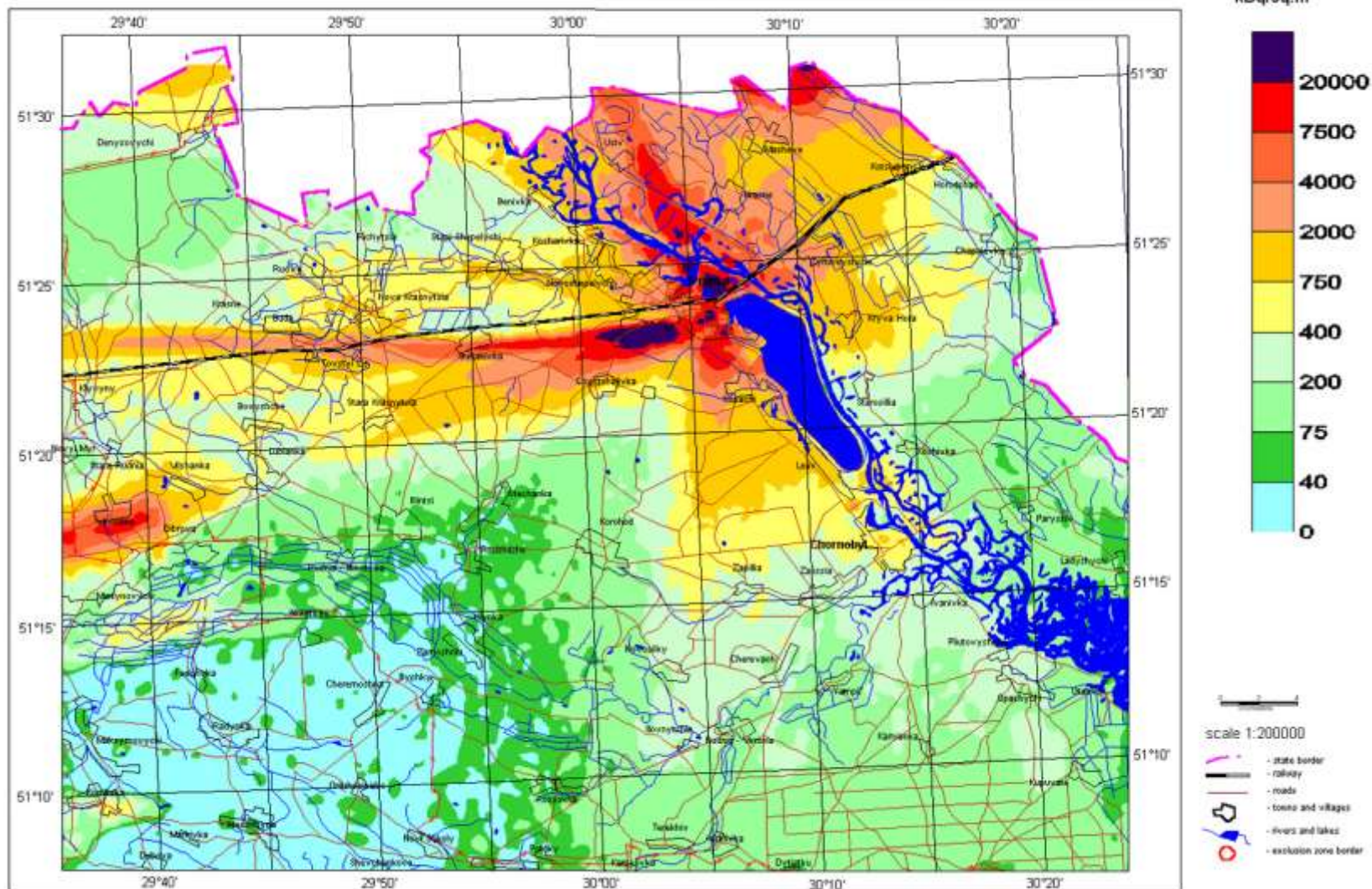
Valeriy Yurko



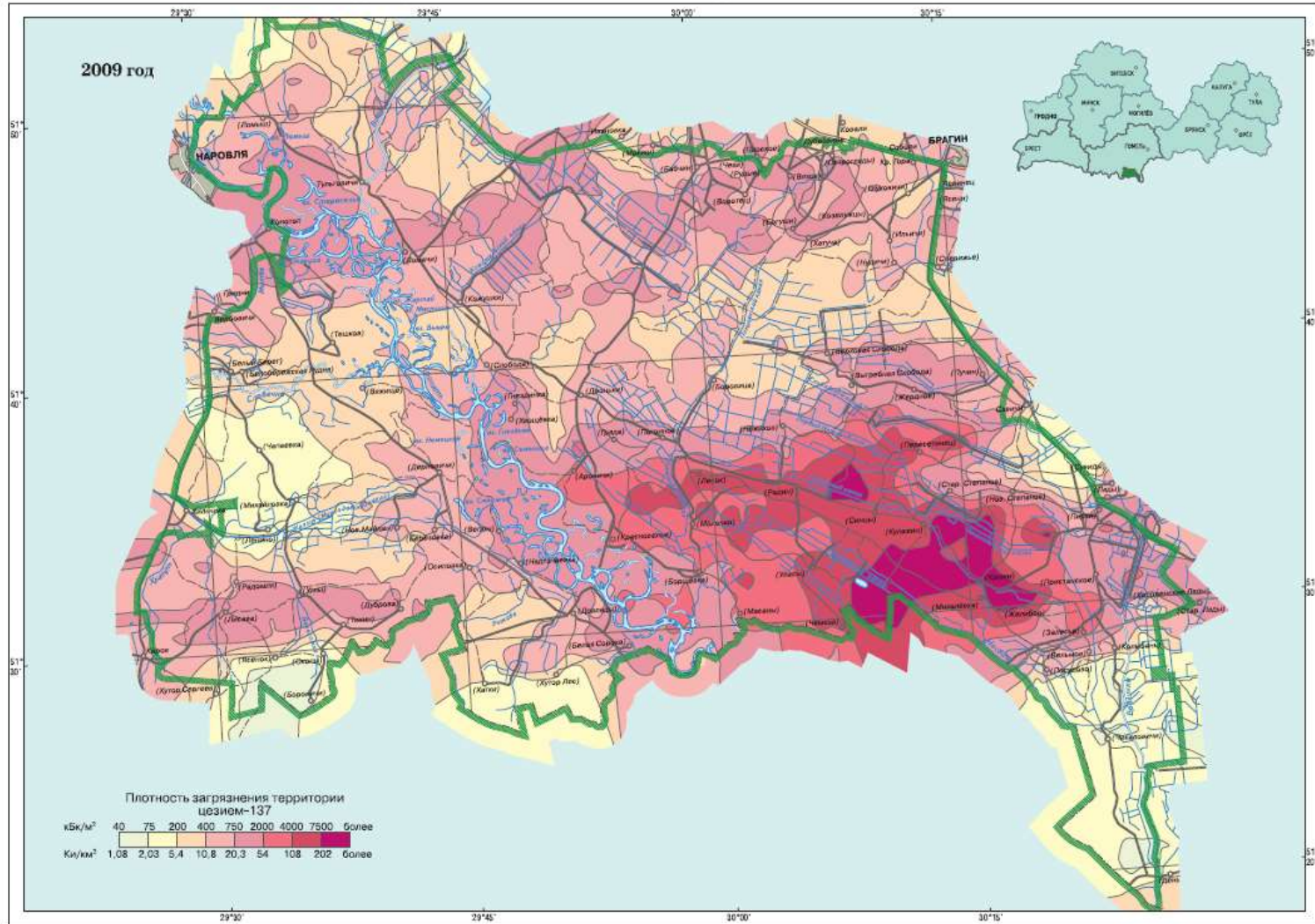
# Thresholds for deterministic effects

- 100 mGy ( $10^5$   $\mu$ Gy acute dose) assumed for humans
- ( $11 \mu$ Gy  $h^{-1}$  for 1 year continuous exposure gives 100 mGy total dose to wildlife)
- $>100 \mu$ Gy  $h^{-1}$  for damage from chronic radiation to mammals (Real et al. 2004)

The map of the 30-km Chernobyl zone terrestrial density of contamination with cesium-137 ( on 1997 )



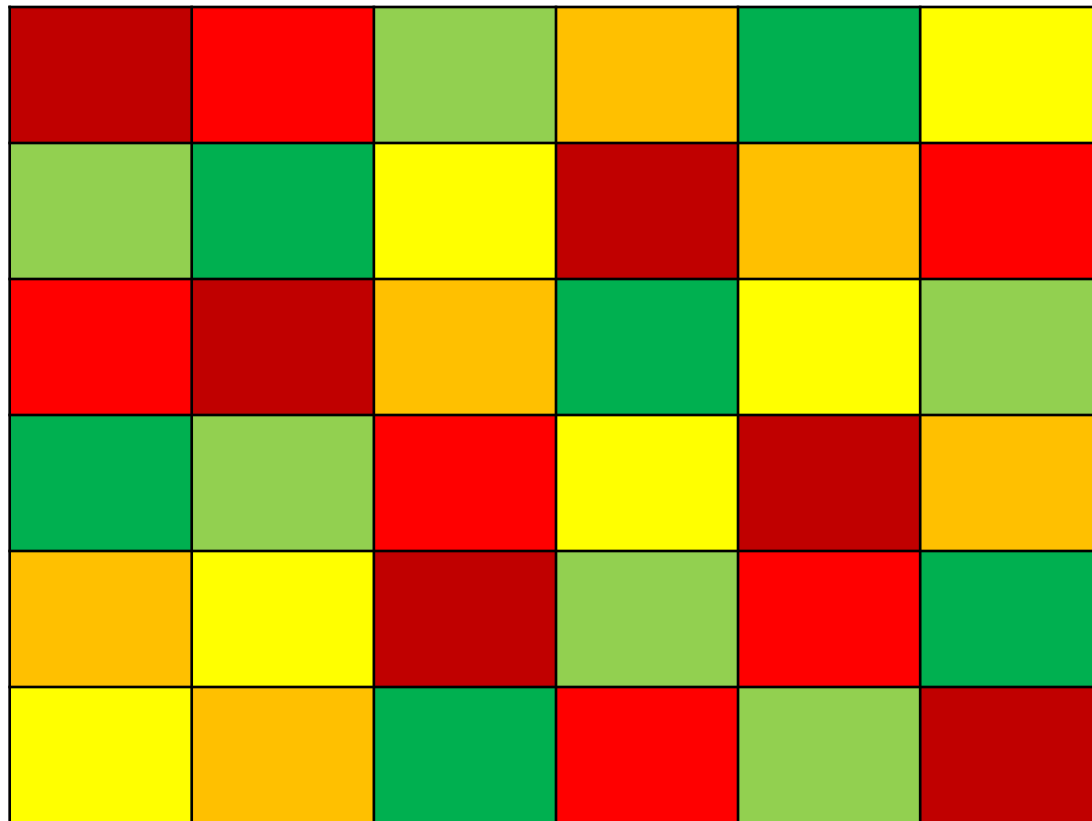
ПОЛЕСКИЙ ГОСУДАРСТВЕННЫЙ РАДИАЦИОННО-ЭКОЛОГИЧЕСКИЙ ЗАПОВЕДНИК. ЗАГРЯЗНЕНИЕ ЦЕЗИЕМ-137



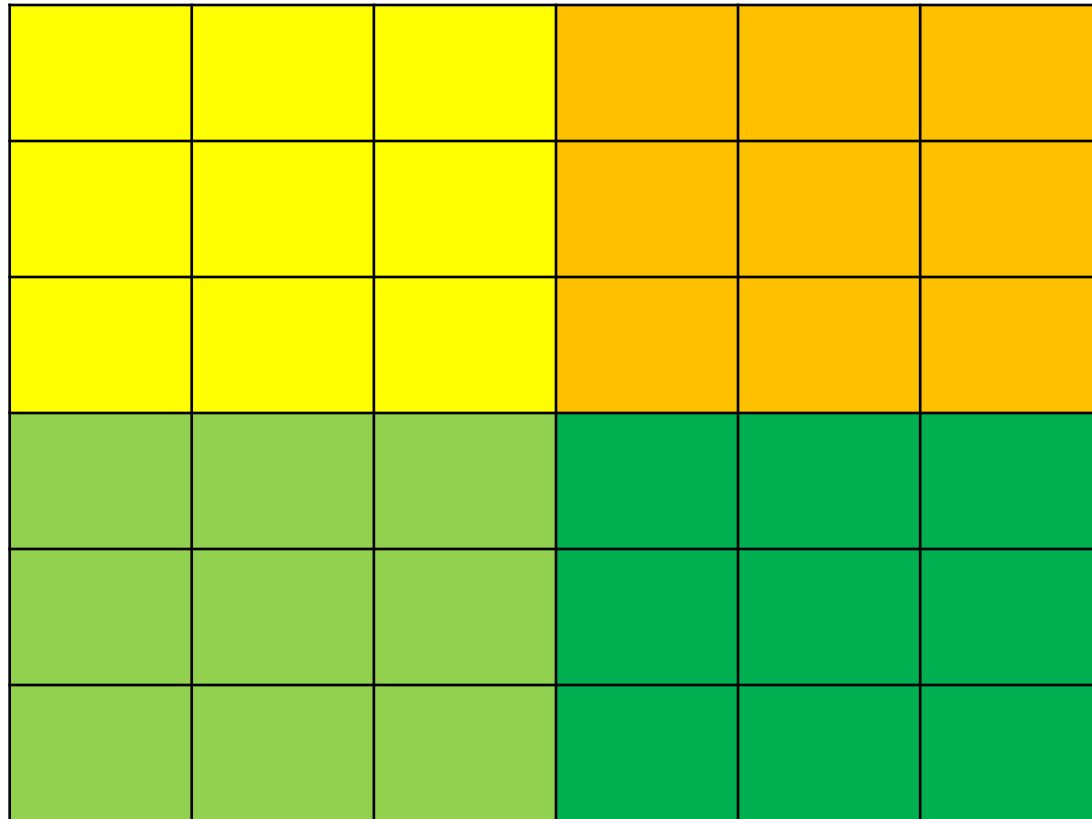
Atlas of Radioactive Contamination in Russia and Belarus,  
2009

What if we'd designed it ?

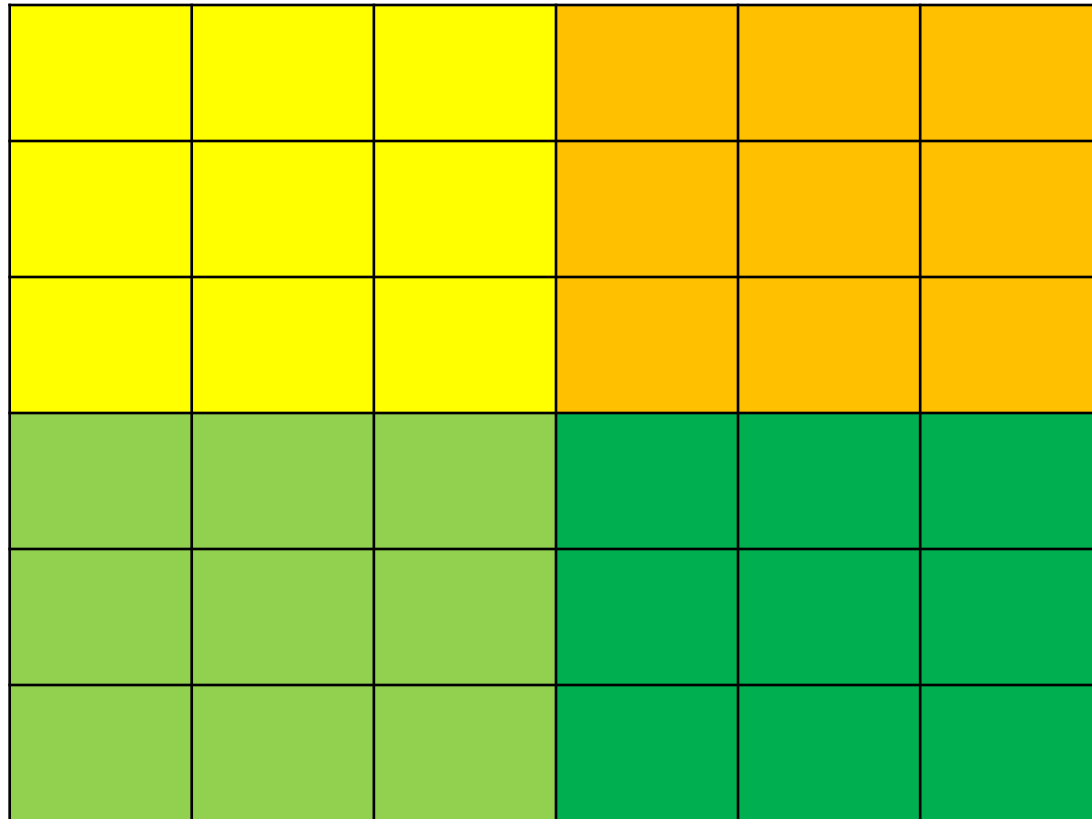
# Contamination density...



# Habitat variable 1...



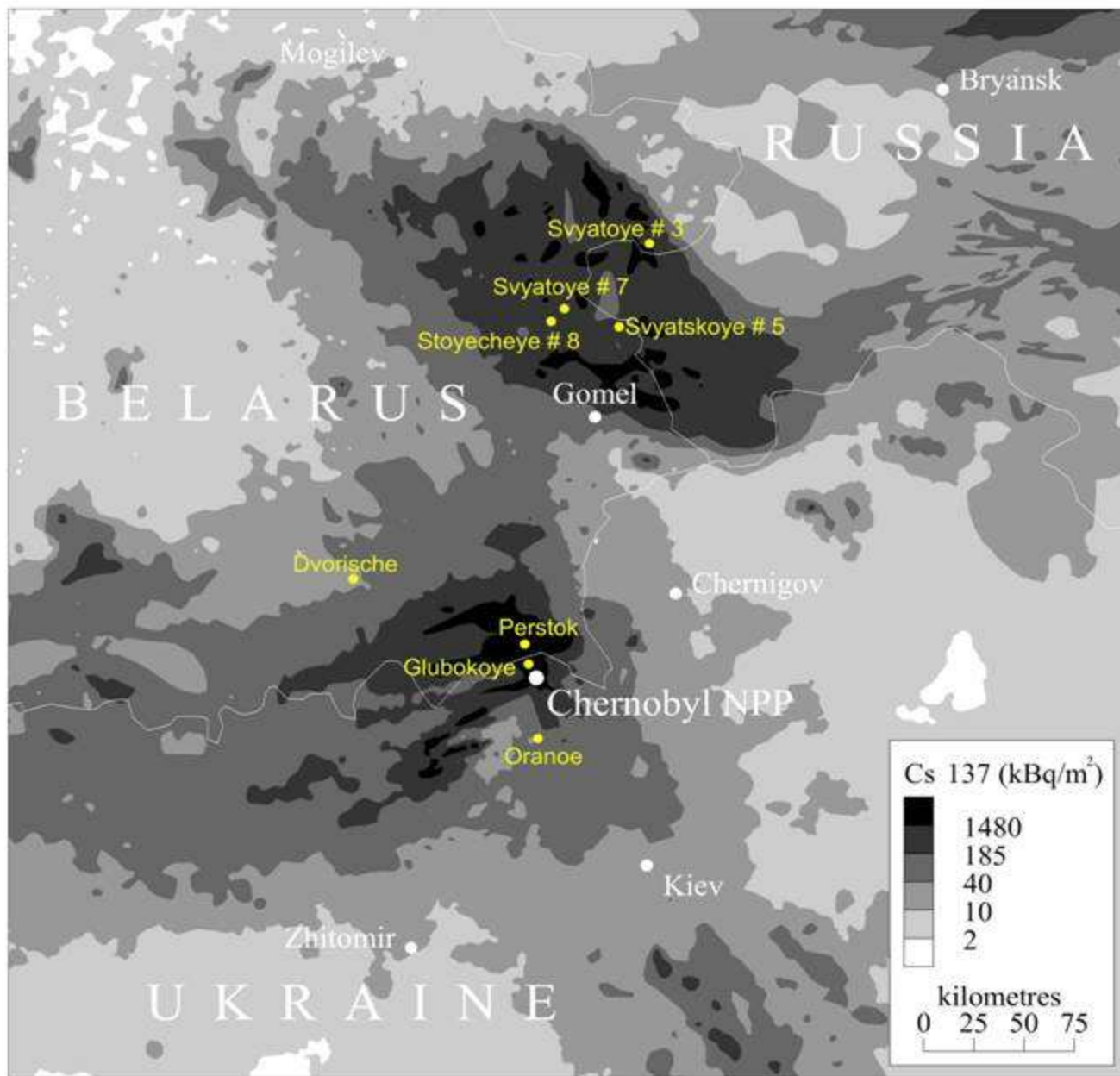
# Habitat variable 2...



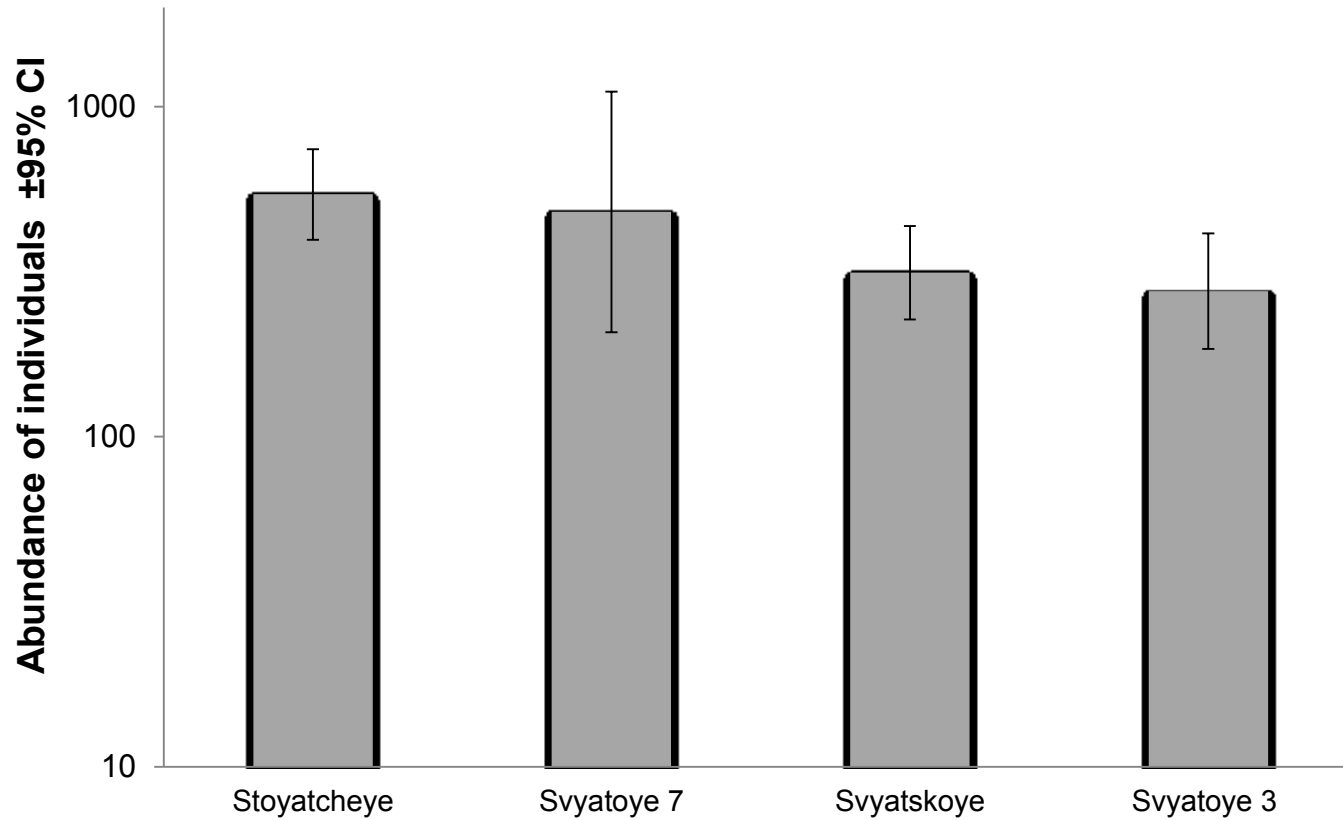


# Statistical errors

- Type I error:
  - Incorrect rejection of a true null hypothesis
  - “False positive”
  
- Type II error:
  - Failure to reject a false null hypothesis
  - “False negative”

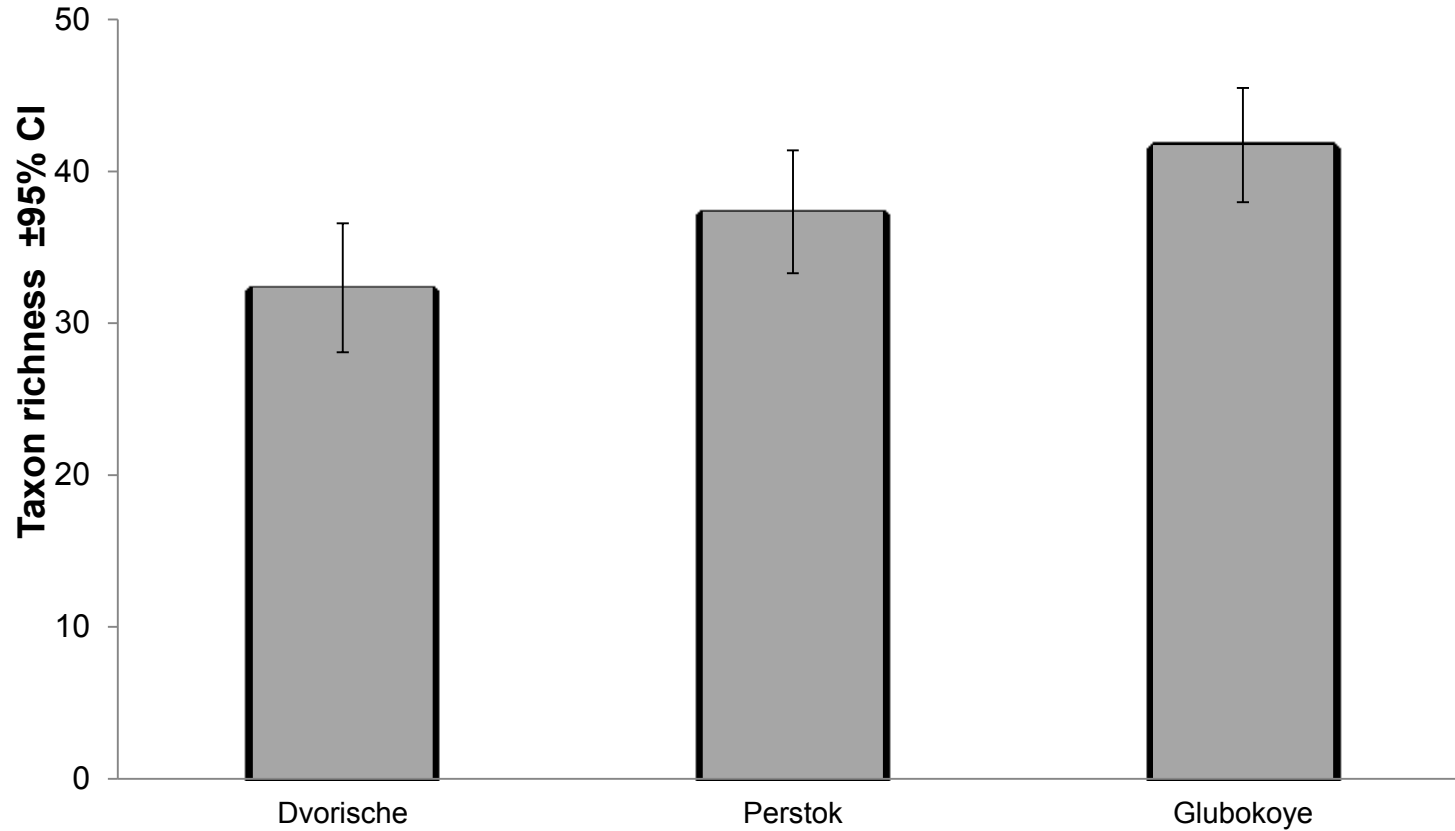


## Mogilev region lakes

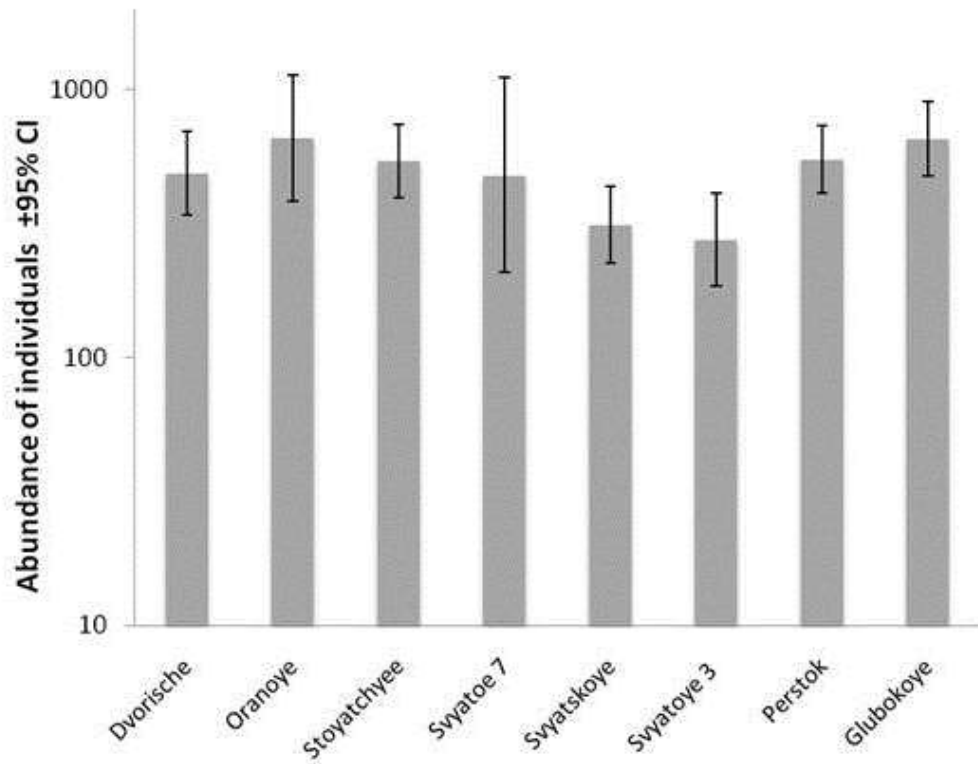


Increasing contamination →

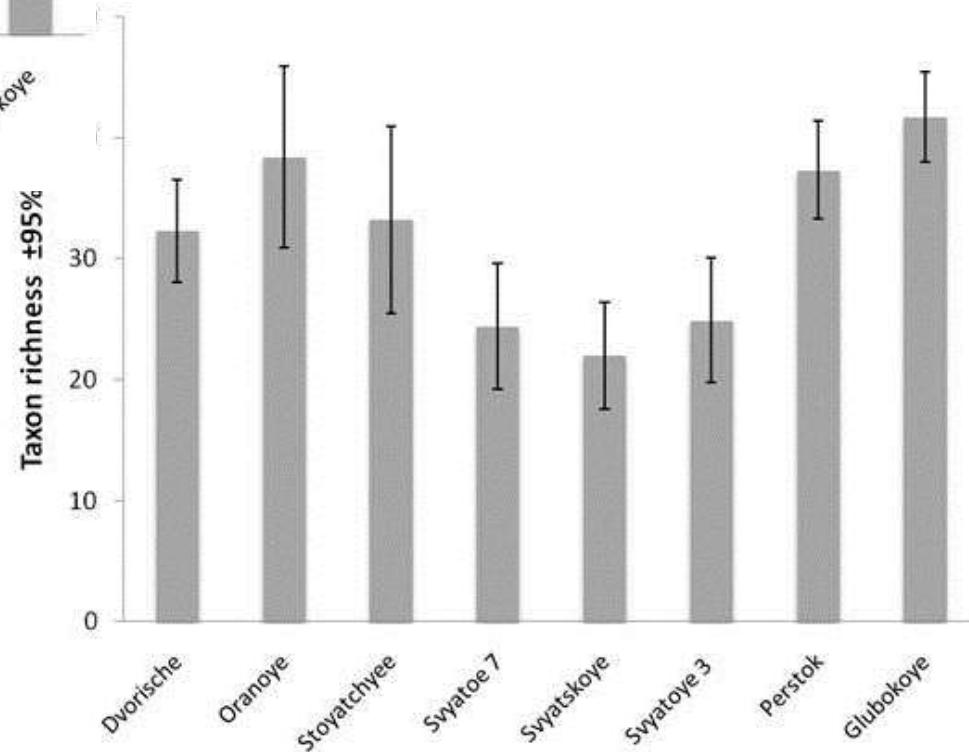
## Pripyat floodplain lakes



Increasing contamination →



Increasing contamination →



Could be a false negative !

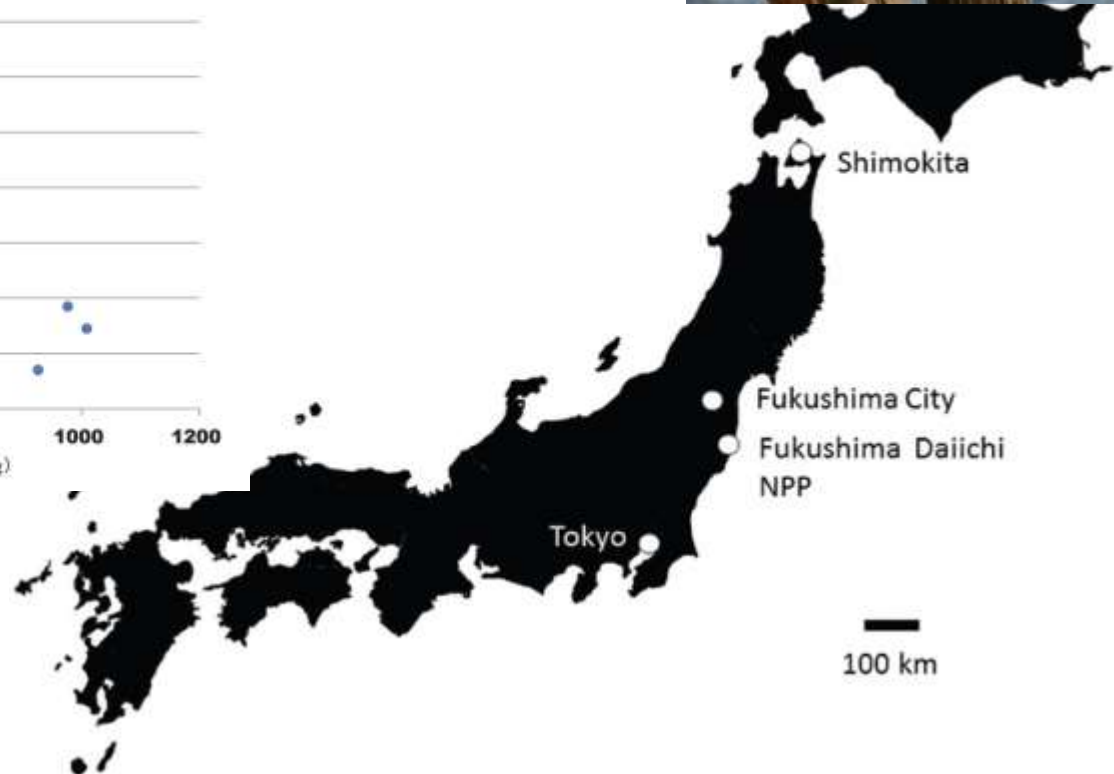
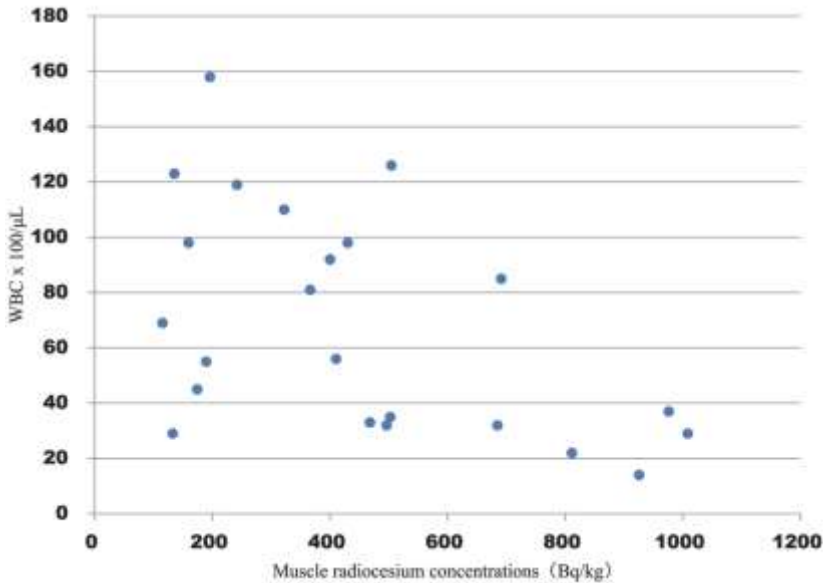
# Statistical model

*Effect endpoint = Environmental variables + Radiation + Error*

- There are many potential environmental variables;
- *Error* term is usually high;
- *Radiation* term is likely much weaker than *environmental variables + error*
  - ▶ There are no true control sites
  - ▶ Need a high  $N$  (lots of degrees of freedom)

# Low blood cell counts in Fukushima monkeys

- Statistically significant difference in 4 blood cell endpoints between Fukushima and Shimokita;
- One of four endpoints showed negative relationship with internal Cs-137



Ochiai et al.  
(2014) *Sci. Rep.*



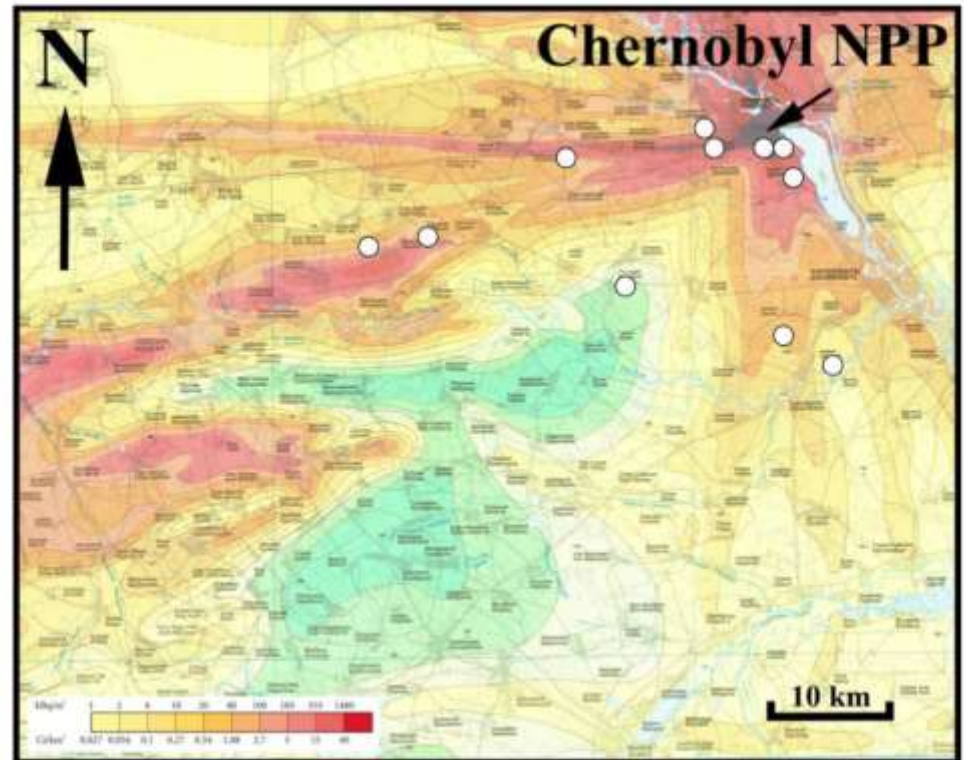
# Reasons to be skeptical:

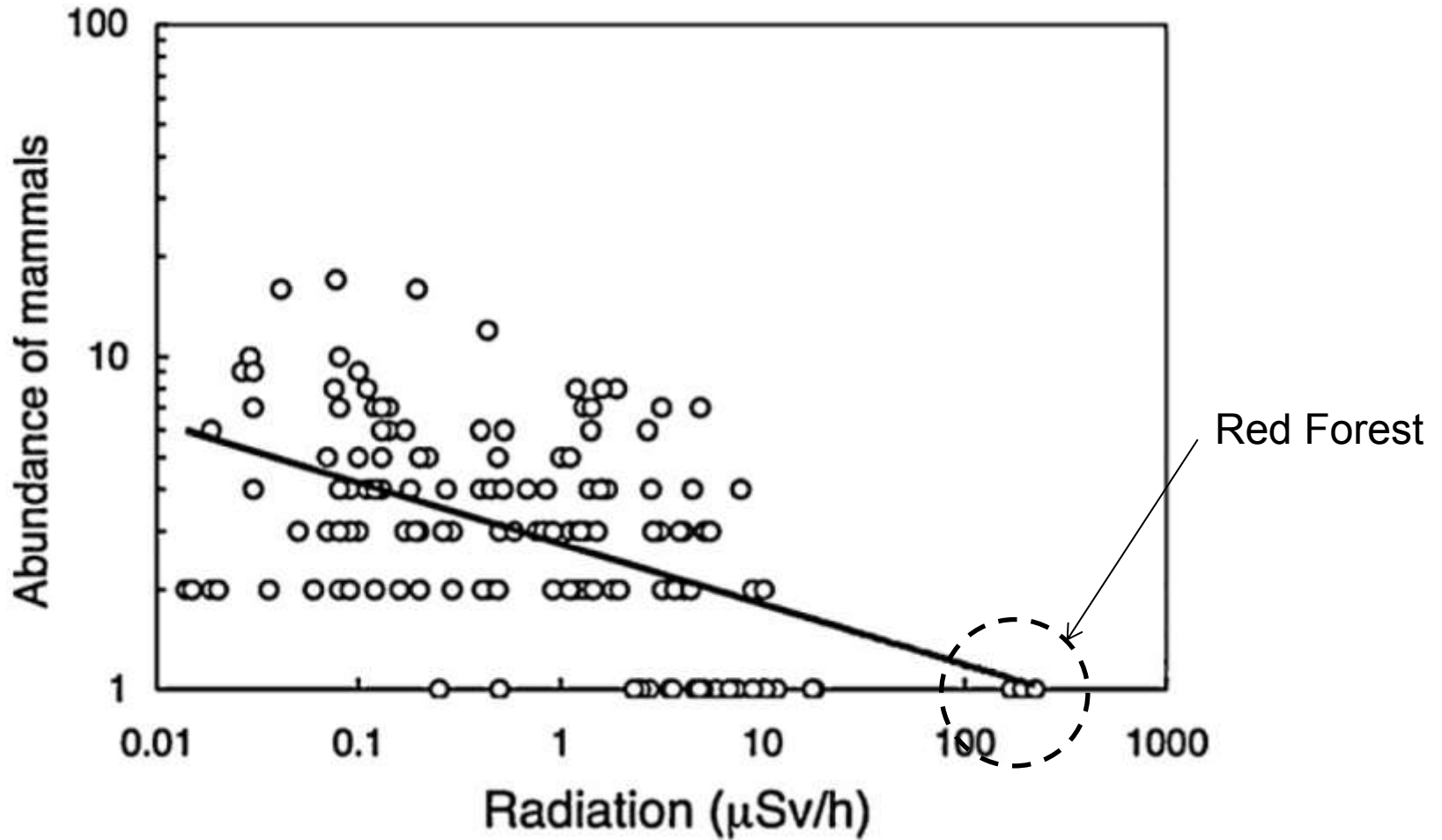
- $N = 2$  for comparisons between sites!
- No difference between 2 Fukushima groups at different contamination levels
- Only 1 of 4 endpoints showed a dose-response
- Cs dose rate up to 0.6  $\mu\text{Gy}/\text{h}$ ; 6  $\text{mGy}/\text{yr}$   
c.f. CT scan 10  $\text{mGy}$  acute
- No consideration of likely early high thyroid doses from I-131

# Study of mammals, Ukraine

161 x 100m Tracks

Statistically significant  
( $P < 0.0001$  !) negative  
correlation between  
abundance and dose

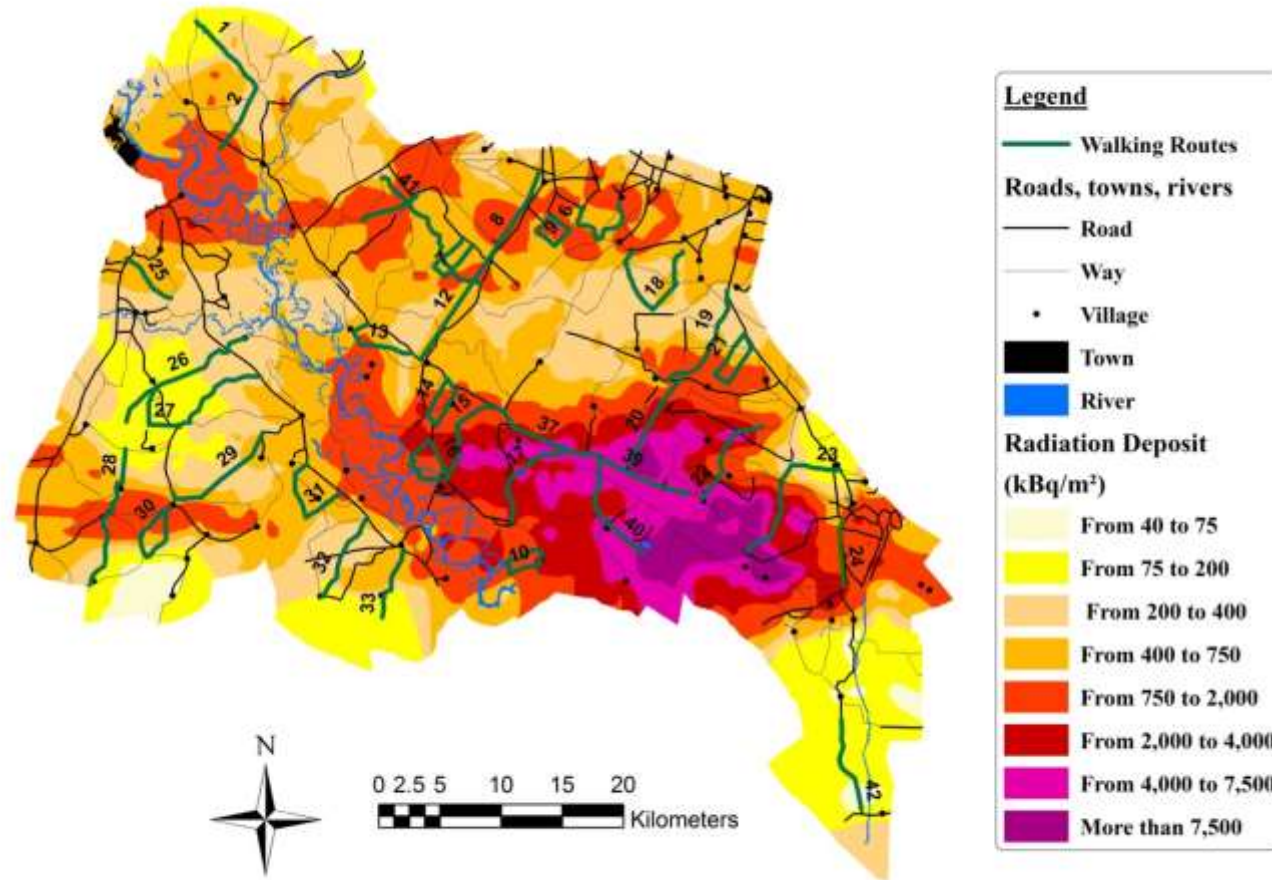




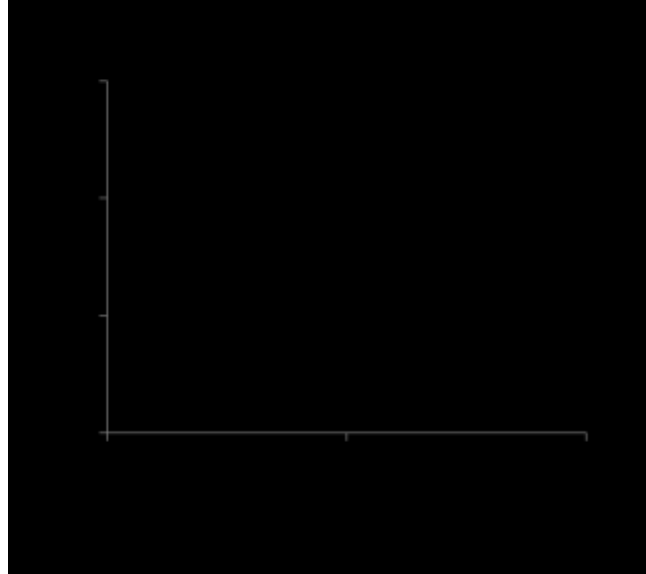
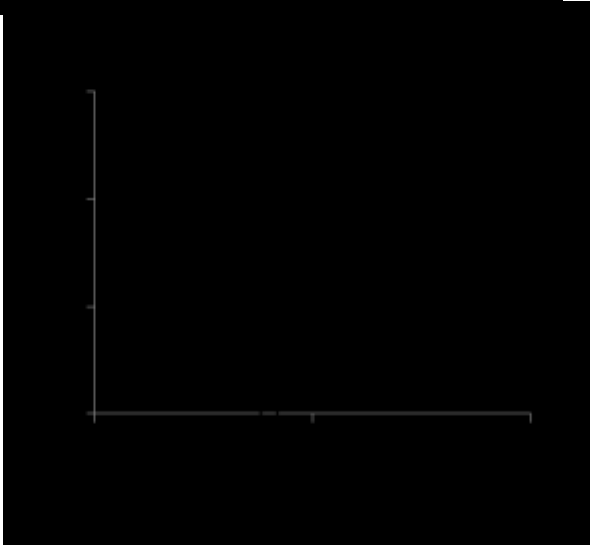
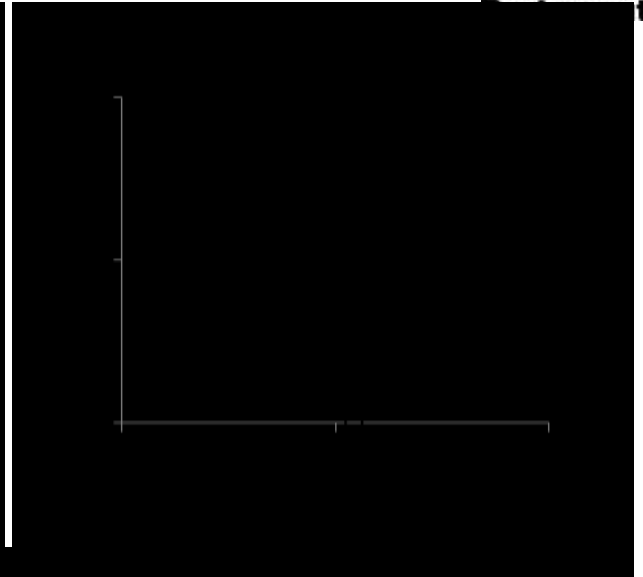
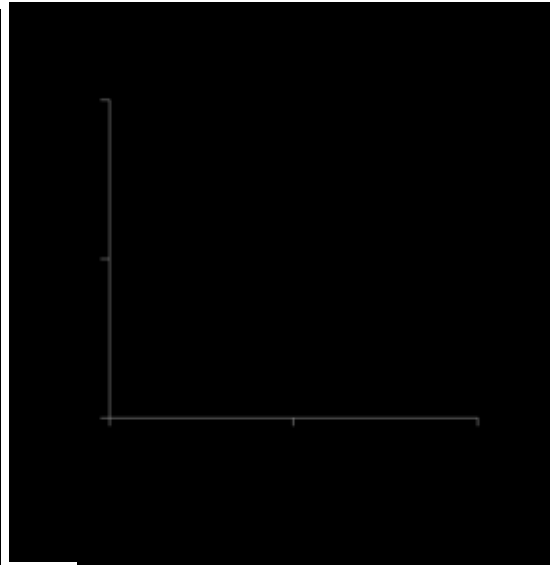
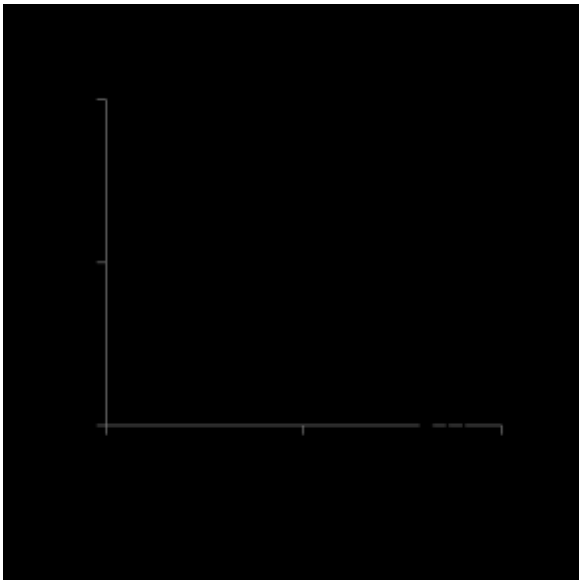
# Reasons to be skeptical:

- What is the leverage of the 3 Red Forest transects ?
- What is the effect at 20 uGy/hr or less ?
- 70 wolf counts in 16 km of track... there are only ca. 40 wolves in the Ukraine sector of the zone (Shkvyria & Vishnevsky, 2012)
- But 161 d.f. assumes all 161 x 100m transects are independent...

# Snow track surveys, Belarus



Deryabina, Kuchmel, Nagorskaya, Hinton, Beasley, Lerebours, Smith (2015) *Current Biology*



**Track counts per  
10 km of route,  
315 km of routes**

Weasel, lynx, raccoon dog, mink,  
ermine, stone marten, polecat, pine  
marten.

Red squirrel, european hare, white hare

Could be a false negative !

## Drugs research hampered by substandard animal testing procedures

Survey of thousands of animal studies for drugs to combat disease finds majority not rigorous enough, leading to trials that waste time, money and suffering



Two extensive research projects have found the majority of drug testing on animals use inadequate and ineffective procedures. Photograph: Alamy

- > 650 out of 1000 papers failed to report any of four key factors necessary to reduce bias
- Found there was less attempt to rule out bias in papers in top-flight journals !!!